



Faculty of Manufacturing Engineering

**REGRESSION MODELS OF MUSCLE ACTIVITY,
PSYCHOPHYSICAL EXPERIENCE AND HEART RATE IN
MANUAL LIFTING TASK**

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Master of Science in Manufacturing Engineering

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**REGRESSION MODELS OF MUSCLE ACTIVITY, PSYCHOPHYSICAL
EXPERIENCE AND HEART RATE IN MANUAL LIFTING TASK**

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**A thesis submitted
in fulfillment of the requirements for the degree of Master of Science
in Manufacturing Engineering**

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DECLARATION

I declare that this thesis entitled “Regression Models of Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting Task” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering.

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DEDICATIONS

Alhamdulillah, I am most grateful to Almighty Allah S.W.T for blessing me with good health and ideas in completing this research successfully.

Special thanks to my family for their continuous supports especially my parents, Tuan Haji Omar b. Mohd Dali and Hajjah Che Bah bt. Mohd Noh. Your daughter always loves and misses you while completing the study. To my beloved brothers and family members, I am really grateful for all the support mentally and financially. Thanks for always encourage, advice and support me during my study. I am really grateful of you for always been there and accompany me.

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ABSTRACT

The mismatch between human and work system can influence workers' efficiency, productivity, and occupational health. Improper design of manual materials handling (MMH) tasks in manufacturing industry is one of the causes of this mismatch, which is one of risk factors leading to various occupational injuries such as back pain, neck pain, and sprain and strain in the muscles. Engineers and managements require a regression model to design work process related to MMH tasks. The regression model must be able to predict the effects of MMH parameters such as load mass, lifting height, and twist angle to workers' physical characteristics including muscle activity, psychophysical experience, and heart rate. Existing studies, guidelines and tools related to industrial ergonomics have shown a limitation in predicting the effects of MMH on human physical. Thus, a development of regression model for designing MMH that can meet above requirement is needed. The aim of this study is to develop regression models of muscle activity, psychophysical experience, and heart rate with respect to load mass, lifting height, and twist angle for the purpose of predicting and redesigning the MMH processes. This study performed questionnaire survey at industries, experiments on manual lifting task using full factorial design of experiment, develop and validate regression models through statistical analysis. In experimental task, ten female with equal numbers of male subjects with no musculoskeletal disorders were paid to perform eight lifting tasks with five replications for each task. Results of this study found that the developed regression models able to predict the electromyography (EMG) signals in the erector spinae and biceps brachii, psychophysical experience (Borg Scale), and heart rate (beats per minute) when the load mass in the range of 5 kg to 15 kg, 55 cm to 130 cm of lifting height, and twist angle ranging from 0 degrees to 90 degrees. Based on the developed regression models, this study concluded that the load mass contributed the greatest effect to muscle activity, psychophysical experience, and heart rate. It is expected that the use of developed regression models may facilitate the MMH process design through the optimization of muscle activity, psychophysical experience, and heart rate. Hence, better compatibility of MMH task and worker may be achieved resulting in efficiency, productivity and occupational health improvement.

ABSTRAK

Ketidakpadanan antara manusia dan sistem kerja boleh mempengaruhi kecekapan pekerja, produktiviti dan kesihatan pekerjaan. Aktiviti mengangkat secara manual yang tidak dilakukan secara ergonomik dalam industri pembuatan merupakan salah satu punca kepada ketidakpadanan ini, yang diketahui sebagai punca kepada pelbagai kecederaan pekerjaan seperti sakit belakang, sakit leher, terseliuh dan tegang otot. Jurutera dan pihak pengurusan industri memerlukan satu model regresi untuk merekabentuk proses kerja berkaitan aktiviti angkatan manual. Model tersebut mesti boleh meramal kesan faktor-faktor aktiviti angkatan manual seperti berat beban, tinggi paras angkatan dan sudut pusingan terhadap ciri-ciri fizikal pekerja termasuk aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung. Kajian, garis panduan dan alat berkaitan ergonomik industri yang sedia ada mempunyai batas untuk meramal kesan aktiviti angkatan manual terhadap fizikal pekerja. Maka, satu pembangunan model regresi untuk merekebentuk aktiviti angkatan manual yang dapat memenuhi kriteria di atas adalah diperlukan. Tujuan kajian ini adalah untuk merangka model regresi untuk meramal aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung terhadap berat beban, tinggi paras angkatan dan sudut pusingan untuk merekebentuk semula proses aktiviti angkatan manual. Kajian ini telah menjalankan kaji selidik di tempat kerja dalam industri, eksperimen terhadap aktiviti angkatan manual menggunakan reka bentuk faktorial penuh dan model regresi ini akan dirangka dan disahkan dengan menggunakan analisis statistik. Sepuluh subjek perempuan dan sepuluh subjek lelaki yang sihat tubuh badan dan bebas dari masalah otot berangka dibayar untuk melakukan lapan aktiviti angkatan manual. Setiap angkatan manual akan diulang sebanyak lima kali. Hasil kajian mendapati model regresi yang dibangunkan ini dapat meramal isyarat electromyography (EMG) di otot erektor spina dan bisep brachii, pengalaman psikofizikal (Skala Borg), dan kadar denyutan jantung apabila berat beban diantara 5 kg hingga 15 kg, 55 cm hingga 130 cm tinggi paras angkatan dan sudut pusingan diantara 0 darjah hingga 90 darjah. Berdasarkan model regresi yang dibangunkan, kajian ini membuat kesimpulan bahawa berat beban, menyumbang kesan yang paling besar terhadap aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung. Kajian ini menjangkakan model regresi yang dibangunkan ini dapat memudahkan proses rekabentuk mengangkat secara manual melalui pengoptimuman aktiviti otot, pengalaman psikofizikal dan kadar denyutan jantung. Maka, keserasian yang lebih baik dapat dicapai di antara aktiviti mengangkat secara manual dan pekerja supaya dapat meningkatkan kecekapan, produktiviti dan kesihatan pekerjaan.

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TABLE OF CONTENTS

	PAGE
DECLARATION	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	xii
LIST OF APPENDICES	xviii
LIST OF ABBREVIATIONS	xix
LIST OF PUBLICATIONS	xx
CHAPTER	
1. INTRODUCTION	1
1.1 Background of Study	1
1.2 Problem Statements	5
1.3 Objectives of Study	6
1.4 Research Questions	7
1.5 Scope and Limitations	8
1.6 Potential Benefits of Study	9
1.7 Thesis Organization	9
1.8 Summary	10
2. LITERATURE REVIEW	12
2.1 Fundamentals of Manual Lifting Tasks	12
2.2 Occupational Injuries Related to Manual Lifting Tasks	13
2.3 Feasible Methods for Conducting Studies in Manual Lifting Tasks	16
2.3.1 Muscle Activity (EMG Signals)	16
2.3.2 Psychophysical Experience (Borg Scale)	18
2.3.1 Heart Rate	20
2.4 The Gap between Previous Studies and Current Study in Manual Lifting Task	20
2.5 Summary	30

3. METHODOLOGY	31
3.1 Analyzing the Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting	31
3.1.1 Determination of the Variables and Experimental Settings	39
3.1.1.1 Workplace Observation and Industrial Visits	39
3.1.1.2 Literature Review / Research Gap	40
3.1.1.3 Preliminary Experiment	41
3.1.2 Experimental Settings	42
3.1.3 Actual Experiments	43
3.1.3.1 Subjects	43
3.1.3.2 Muscle Activity (EMG signals)	44
3.1.3.3 Skin Preparation and Electrode placement	46
3.1.3.4 Maximum Voluntary Contraction (MVC)	50
3.1.3.5 EMG Signals Processing	51
3.1.3.6 Psychophysical Experience	53
3.1.3.7 Heart Rate	53
3.1.4 Workstation Design and Standard Operation Procedure	54
3.1.4.1 Workstation Design	54
3.1.4.2 Standard Operation Procedure (SOP)	55
3.2 Formulate the Mathematical Modeling of Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting Task	58
3.2.1 Muscle Activity	58
3.2.1.1 Analysis of Variance (ANOVA)	58
3.2.2 Psychophysical Experience	60
3.2.2.1 Analysis of Variance (ANOVA)	60
3.2.2 Heart Rate	60
3.2.2.1 Analysis of Variance (ANOVA)	60
3.3 Validation and Optimization of the Mathematical Modeling of Muscle Activity, Psychophysical Experience and Heart Rate during Manual Lifting Task	61
3.4 Summary	64
4. RESULTS	65
4.1 Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting	65
4.1.1 Independent Variables Determined through Questionnaire Survey	65
4.1.2 Descriptive Analysis of Muscle Activity	70
4.1.2.1 Right Erector Spinae	70
4.1.2.2 Left Erector Spinae	70
4.1.2.3 Right Biceps Brachii	71
4.1.2.4 Left Biceps Brachii	72
4.1.2.5 Summary of Muscle Activity According	73

	to Genders	
	4.1.2.6 Comparison of EMG Signals with Maximum Voluntary Contraction (MVC)	76
4.1.3	Descriptive Analysis of Psychophysical Experience	82
4.1.3.1	Right Erector Spinae	82
4.1.3.2	Left Erector Spinae	83
4.1.3.3	Right Biceps Brachii	83
4.1.3.4	Left Biceps Brachii	84
4.1.3.5	Summary of Psychophysical Experience According to Genders	85
4.1.4	Descriptive Analysis of Heart Rate	88
4.2	Mathematical Modeling of Muscle Activity, Psychophysical Experience and Heart Rate	89
4.2.1	Muscle Activity	90
4.2.1.1	Right Erector Spinae	92
4.2.1.2	Left Erector Spinae	100
4.2.1.3	Right Biceps Brachii	106
4.2.1.4	Left Biceps Brachii	114
4.2.2	Psychophysical Experience	121
4.2.2.1	Right Erector Spinae	123
4.2.2.2	Left Erector Spinae	130
4.2.2.3	Right Biceps Brachii	137
4.2.2.4	Left Biceps Brachii	145
4.2.3	Heart Rate	152
4.3	Validation and Optimization of the Mathematical Models of Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting Task	160
4.3.1	Muscle Activity	161
4.3.2	Psychophysical Experience	163
4.3.3	Heart Rate	164
4.4	Summary	165
5.	DISCUSSION	167
5.1	Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting	167
5.1.1	Independent Variables Determined through Questionnaire Survey	167
5.2	Mathematical Modeling of Muscle Activity, Psychophysical Experience and Heart Rate	169
5.2.1	Relationship of Lifting Height, Load Mass and Twist Angle to Muscle Activity	169
5.2.1.1	Erector Spinae	169
5.2.1.2	Biceps Brachii	171
5.2.2	Relationship of Lifting Height, Load Mass and Twist Angle to Psychophysical Experience	172
5.2.2.1	Erector Spinae	172

5.2.2.2	Biceps Brachii	173
5.2.3	Relationship of Lifting Height, Load Mass and Twist Angle to Heart Rate	174
5.3	Validation and Optimization of the Mathematical Models of Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting Task	175
5.4	Summary	176
6.	CONCLUSION AND RECOMMENDATIONS	178
6.1	Analysis of Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting	178
6.2	Mathematical Modeling of Muscle Activity, Psychophysical Experience and Heart Rate	179
6.3	Validation and Optimization of the Mathematical Models of Muscle Activity, Psychophysical Experience and Heart Rate in Manual Lifting Task	180
6.4	Recommendation for Future Research	181
	REFERENCES	182
	APPENDICES	192
	Appendix A	
	Appendix B	
	Appendix C	
	Appendix D	
	Appendix E	

LIST OF TABLES

TABLES	TITLE	PAGE
2.1	Number of man-days lost due to accident according to age and gender in 2013	15
2.2	Previous studies regarding dependent and independent variables in manual lifting	21
3.1	Factors and levels used in this study	35
3.2	Selection of factors based on industrial visits and literature review	41
3.3	Demographic profile of the subjects (preliminary experiment)	42
3.4	Demographic profile of the subjects (actual experiment)	45
3.5	Equipment for skin preparation and electrode placement	46
3.6	Standard operation procedures for manual lifting task	55
4.1	Demographic of the workers	66
4.2	Discomfort levels rated by the workers in selected body parts	69
4.3	P-value of T-test between genders for EMG signals	76
4.4	P-value of T-test between genders for psychophysical experience	86
4.5	P-value of the normality test for EMG signals (μV)	90
4.6	Probability plot of EMG signal for all muscles	91
4.7	ANOVA of EMG signal in the right erector spinae of female subjects	92

4.8	New ANOVA of EMG signals in the right erector spinae of female subjects	93
4.9	ANOVA of EMG signals in the right erector spinae of male subjects	94
4.10	New ANOVA of EMG signals in the right erector spinae of male subjects	95
4.11	ANOVA of EMG signal in the left erector spinae of female subjects	102
4.12	ANOVA of EMG signal in the left erector spinae of male subjects	102
4.13	ANOVA of EMG signals in the right biceps brachii of female subjects	107
4.14	New ANOVA of EMG signals in the right biceps brachii of female subjects	108
4.15	ANOVA of EMG signal in the right biceps brachii of male subjects	109
4.16	ANOVA of EMG signals in the left biceps brachii of female subjects	114
4.17	New ANOVA of EMG signal in the left biceps brachii of female subjects	115
4.18	ANOVA of EMG signals in the left biceps brachii of male subjects	116
4.19	New ANOVA of EMG signals in the left biceps brachii of male subjects	117
4.20	P-value of the normality test for psychophysical experience (Borg Scale)	121
4.21	Probability plot of Borg Scale for all muscles	122
4.22	ANOVA of Borg Scale in the right erector spinae of female subjects	123
4.23	ANOVA of Borg Scale in the right erector spinae of male subjects	125
4.24	New ANOVA of Borg Scale in the right erector spinae of male subjects	126

	subjects	
4.25	ANOVA of Borg Scale in the left erector spinae of female subjects	131
4.26	New ANOVA of Borg Scale in the left erector spinae of female subjects	132
	subjects	
4.27	ANOVA of Borg Scale in the left erector spinae of male subjects	133
4.28	New ANOVA of Borg Scale in the left erector spinae of male subjects	134
	subjects	
4.29	ANOVA of Borg Scale in the right biceps brachii of female subjects	138
4.30	New ANOVA of Borg Scale in the right biceps brachii of female subjects	139
	subjects	
4.31	ANOVA of Borg Scale in the right biceps brachii of male subjects	140
4.32	New ANOVA of Borg Scale in the right biceps brachii of male subjects	141
	subjects	
4.33	ANOVA of Borg Scale in the left biceps brachii of female subjects	145
4.34	ANOVA of Borg Scale in the left biceps brachii of male subjects	147
4.35	New ANOVA of Borg Scale in the left biceps brachii of male subjects	148
	subjects	
4.36	Probability plot and P-Value of normality test for heart rate	152
4.37	ANOVA of heart rate of female subjects	153
4.38	New ANOVA of heart rate of female subjects	154
4.39	ANOVA of heart rate of male subjects	155
4.40	New ANOVA of heart rate of male subjects	156
4.41	P-value of T-test for validation of mathematical models of EMG signals	161

4.42	Optimization of the EMG signals for female and male subjects	162
4.43	P-value of T-test for validation of mathematical models of psychophysical experience (Borg Scale)	163
4.44	Optimization of the psychophysical experience of female and male subjects	164
4.45	P-value of T-test for validation of mathematical models of heart rate	165
4.46	Optimization of the heart rate of female and male subjects	165

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Exposure to bending posture in manual lifting task	2
2.1	Squat and stoop lifting techniques	13
2.2	Occupational accident statistics by sector until August 2015	14
2.3	Position of electrode placement in the erector spinae and biceps brachii	17
2.4	SENIAM guidelines to assess selected muscles	17
2.5	Borg Scale perceived exertion CR10	19
3.1	Research flow chart	38
3.2	Subjects performing manual lifting task	43
3.3	Power and sample size calculation	44
3.4	Surface Electromyography (sEMG) TeleMyo 2400T G2 Transmitter	45
3.5	Skin preparation and electrode placement	47
3.6	Placement of sEMG electrodes at the selected muscles	49
3.7	Placement for channel 1 of sEMG system	49
3.8	Maximum strength test by using back-leg-chest dynamometer	50
3.9	Maximum Voluntary Contraction of the subjects	51
3.10	Signal processing from the EMG raw signals to muscle activity (+ve)	52
3.11	Polar FT2 heart rate monitor	53

3.12	Measuring and marking the twist angle using Arthrodiagonal Protector	54
3.13	Lifting height	56
3.14	Position of box with respect to twist angles	56
3.15	Steps of manual lifting task experiment	57
3.16	Steps to perform the Anderson-Darling normality test	59
3.17	Steps for optimization of the EMG signals	63
4.1	Lifting techniques applied by the workers	66
4.2	Lifting height performed by the workers	67
4.3	Mass of load used in manual lifting lifted by the workers	67
4.4	Posture of workers when performing manual lifting task	68
4.5	Comparison of EMG signals (μV) in the right erector spinae between genders	70
4.6	Comparison of EMG signals (μV) in the left erector spinae between genders	71
4.7	Comparison of EMG signals (μV) in the right biceps brachii between genders	72
4.8	Comparison of EMG signals (μV) in the left biceps brachii between genders	73
4.9	EMG signals (μV) for female subjects	74
4.10	EMG signals (μV) for male subjects	75
4.11	Percentage of MVC in the right erector spinae of female subjects according to lifting task	77
4.12	Percentage of MVC in the right erector spinae of male subjects according to lifting task	77

4.13	Percentage of MVC in the left erector spinae of female subjects according to lifting task	78
4.14	Percentage of MVC in the left erector spinae of male subjects according to lifting task	79
4.15	Percentage of MVC in the right biceps brachii of female subjects according to lifting task	79
4.16	Percentage of MVC in the right biceps brachii of male subjects according to lifting task	80
4.17	Percentage of MVC in the left biceps brachii of female subjects according to lifting task	81
4.18	Percentage of MVC in the left biceps brachii of male subjects according to lifting task	81
4.19	Psychophysical experience in the right erector spinae between genders	82
4.20	Psychophysical experience in the left erector spinae between genders	83
4.21	Psychophysical experience in the right biceps brachii between genders	84
4.22	Psychophysical experience in the left biceps brachii between genders	85
4.23	Psychophysical experience of female subject	87
4.24	Psychophysical experience of male subjects	87
4.25	Comparison of heart rate between female and male subjects	88
4.26	Main effects plot of EMG signals (μV) in the right erector spinae of female subjects	97
4.27	Main effects plot of EMG signals (μV) in the right erector spinae of	97

	male subjects	
4.28	Interaction plot of EMG signals (μV) in the right erector spinae of female subjects	98
4.29	Interaction plot of EMG signals (μV) in the right erector spinae of male subject	99
4.30	Main effects plot of EMG signals (μV) in the left erector spinae of female subjects	103
4.31	Main effects plot of EMG signals (μV) in the left erector spinae of male subjects	104
4.32	Interaction plot of EMG signals (μV) in the left erector spinae of female subjects	105
4.33	Interaction plot of EMG signals (μV) in the left erector spinae of male subjects	105
4.34	Main effects plot of EMG signals (μV) in the right biceps brachii of female subjects	110
4.35	Main effects plot of EMG signals (μV) in the right biceps brachii of male subjects	111
4.36	Interaction plot of EMG signals (μV) in the right biceps brachii of female subjects	112
4.37	Interaction plot of EMG signals (μV) in the right biceps brachii of male subjects	113
4.38	Main effects plot of EMG signals in the left biceps brachii of female subjects	118
4.39	Main effects plot of EMG signals in the left biceps brachii of male	118

	subjects	
4.40	Interaction plot of EMG signals in the left biceps brachii of female subjects	119
4.41	Interaction plot of EMG signals in the left biceps brachii of male subjects	120
4.42	Main effects plot of Borg Scale in the right erector spinae of female subjects	127
4.43	Main effects plot of Borg Scale in the right erector spinae of male subjects	128
4.44	Interaction plot of Borg Scale in the right erector spinae of female subjects	129
4.45	Interaction plot of Borg Scale in the right erector spinae of male subjects	129
4.46	Main effects plot of Borg Scale in the left erector spinae of female subjects	135
4.47	Main effects plot of Borg Scale in the left erector spinae of male subjects	135
4.48	Interaction plot of Borg Scale in the left erector spinae of female subjects	137
4.49	Interaction plot of Borg Scale in the left erector spinae of male subjects	137
4.50	Main effects plot of Borg Scale in the right biceps brachii of female subjects	142
4.51	Main effects plot of Borg Scale in the right biceps brachii of male subjects	143

	subjects	
4.52	Interaction plot of Borg Scale in the right biceps brachii of female subjects	144
4.53	Interaction plot of Borg Scale in the right biceps brachii of male subjects	144
4.54	Main effects plot of Borg Scale in the left biceps brachii of female subjects	149
4.55	Main effects plot of Borg Scale in the left biceps brachii of male subjects	149
4.56	Interaction plot of Borg Scale in the left biceps brachii of female subjects	151
4.57	Interaction plot of Borg Scale in the left biceps brachii of male subjects	151
4.58	Main effects plot of heart rate of female subjects	157
4.59	Main effects plot of heart rate of male subjects	157
4.60	Interaction plot of heart rate of female subjects	159
4.61	Interaction plot of heart rate of male subjects	159

LIST OF APPENDICES

APPENDIX	TITLE
A	Questionnaire survey form
B	Consent form
C	Borg Scale perceived exertion CR10 questionnaire
D	Raw data
E	Table of descriptive analysis